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AUTHOR Jorgensen, Bruce W.
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ABSTRACT

Subjects answered multiple-choice questions at three points in time. They worked alone, then in units of 1, 2, 3, 5, and persons, and again alone. Performance on the task was to provide the following information: (1) initial ability level of subjects; (2) the ability of groups of differing size and leadership to utilize their resources; and, (3) the ability of individuals to acquire correct responses, as a function of their experience on the group task. Performance was predicted using Steiner's (1966, 1972) model of group productivity. Group performance on the task was a position function of group size for the sizes studied. Subsequent individual performance was difficult to interpret: Performance increased with group size for subjects who had been of size 5, and again increased for Ss who had worked in groups of 7. This duplicated the data of a pilot study. Patterns of process adaptation in groups of "critical" size are discussed as possibly responsible for this pattern. It was concluded that groups can facilitate the individual acquisition of knowledge. An application of this information, the small group examination, was discussed. (Author)

GROUP SIZE: ITS EFFECT ON GROUP PERFORMANCE AND ON INDIVIDUAL ACQUISITION OF KNOWLEDGE

BRUCE W. JORGENSEN

UNIVERSITY OF HARTFORD

In a classic 1958 study of group size, Slater concluded that groups of five were, at least from his subjects' viewpoint, the most effective in dealing with intellectual tasks involving the collection or exchange of information, and involving a decision based on an evaluation of that information.

This conclusion is probably an oversimplification of the effect of an "intellectual" task. The potency of task effects on group behavior (c.f. Hackman & Vidmar, 1970) emphasizes the need to determine optimal size not only for different criteria, but for different types of group tasks within the "intellectual task" classification.

This study was designed to test the effects of group size and leadership on group performance and on subsequent individual performance, for one type of intellectual task. To make predictions, a model of group productivity proposed by Steiner (1966, 1972) was utilized. The main features of the model are: (1) A task typology, enabling one to generalize research findings across tasks within a task type; and (2) A plan for relating relevant intervening variables to predict actual group performance.

From the type of task one is interested in, the best possible performance one can expect from a group of a given size can be estimated. This inference is made from a knowledge of task demands and from a knowledge or estimate of group resources. The relationship of group size with process variables, such

as coordination of efforts and member motivation, then enables one to estimate how much groups are likely to deviate from their "best possible performance" due to process losses. The effectiveness of a given group may be predicted, then, using the formula:

Actual Productivity = Potential Productivity-Losses Due to Faulty Process (Steiner, 1966, p. 274).

The optimum group size is that which maximizes the positive discrepancy between potential productivity and process losses. Steiner's task typology facilitates the use of this formula by categorizing tasks primarily according to their determinants of potential productivity.

Steiner's model deals only with the prediction of group performance, but was adapted by this author for the prediction of subsequent individual performance as well. Of interest was the extent to which individuals can learn from cues or information provided by other group members, and circumstances under which group interaction can therefore provide an effective setting for the acquisition of knowledge.

The Task

Subjects attempted to correctly answer a series of 8 multiple-choice questions, first alone, then in groups, and again alone. Subjects' performance on the task was to provide the following information: (1) tha initial level of ability of subjects; . (2) the ability of groups of differing size and leadership to utilize their resources; and (3) the ability of individuals to benefit through the acquisition and retention of information, as a function of their experience on a group task.

The task was thought to represent Steiner's (1972) disjunctive task, where potential group performance on a given question depends upon the ability of the most competent group member. If any one group member can

correctly answer a given question, the group has the potential to select the correct answer, and individual members of the group have the potential of learning the correct answer. If no one in the group initially selects the correct answer, it is unlikely that it will be chosen by the group or accepted subsequently as the correct answer by individual group members.

The main predictions of the study were: (1) Group performance on the task would be a positive function of group size. Process losses were not expected to be great within the range of sizes tested, for this performance criterion. (2) Subsequent individual performance on the task would be a curvilinear function of group size, with the best performance by individuals from groups of intermediate size. The requirements imposed by this second criterion, individual learning, implied additional process losses primarily due to the reduced involvement of less competent members in the group process of the larger groups. It was thought that this lack of participation would render the group decision less salient for later recall for those subjects who stood to gain the most from the group discussion. (3) Group discussion would facilitate the acquisition of knowledge. The acquisition process was conceived of as having two steps, (1) the selection of a correct answer by the group, and (2) the acceptance and retention of the group answer by individual group members.

A pilot study utilizing 168 subjects supported the three main hypotheses. The main study also tested hypotheses that task performance would be better, for groups and individuals, due to reduced process problems: (1) When a discussion leader was selected prior to the group effort on the task, and (2) On later questions of the task.

Method

Subjects

The subjects in the study were 167 students, 72 males and 95 females, enrolled in two sections of a large undergraduate course in social psychology at the University of Massachusetts. They received credit toward their course grade for their participation in the experiment. In addition, 120 other course members not exposed to experimental manipulations answered the task questions on one occasion, as part of a mid-term exam.

Procedure

Subjects worked on the task on two occasions, separated by about a week. In the first session subjects initially answered eight multiple-choice questions individually ($Time_{1i}$). Their performance was a measure of their initial ability level.

Immediately after completing the questions individually in the first session, subjects were assigned to groups of varying sizes to again work on the same task ($Time_{1g}$). Subjects were assigned to units of 1, 2, 3, 5, and 7 members at this time. Persons in groups of 2 and larger were encouraged to work cooperatively with other members of their group and to discuss each question. Half of the groups were given instructions to select a leader, whose responsibilities included insuring that all members participated in the task effort.

Approximately one week after the $Time_{1i}$ and $Time_{1g}$ administrations, subjects again attempted to correctly answer the same set of eight questions as part of a mid-term exam, all subjects working as individuals ($Time_{2i}$). Subjects were given no prior warning of the $Time_{2i}$ task administration.

Results

Results confirmed the first main hypothesis, that group performance would be a direct function of group size within the range of sizes studied. At $Time_{1g}$, scores on the task were a significant positive function of group size.

Results relating to the second main hypothesis, that subsequent performance would be a curvilinear function of discussion group size, were ambiguous. $Time_{2i}$ performance followed the expected pattern through group size five, for both the main study and the pilot, but performance remained a significant positive function of size with the best scores on the task by members of groups of 7. Groups of 5 seemed to suffer from process problems which were effectively dealt with in the larger groups of 7 members.

The third main hypothesis, that group discussion would facilitate the individual acquisition of knowledge, was confirmed. Subjects who had discussed the questions in groups at $Time_{1g}$ performed significantly better than students working on the task for the first time at $Time_{2i}$. Subjects who had worked individually at both $Time_{1i}$ and $Time_{1g}$ performed no better at $Time_{2i}$ than the students working on the task for the first time.

Subordinate hypotheses, that performance would improve with a selected leader, and improve over time, were not confirmed for $Time_{1g}$ or $Time_{2i}$ performance.

Conclusions

Aside from the successful prediction for group performance, some key observations from this study, from the data and related literature were:

Groups are very adaptive for this type of task. Group structure and process are altered as process problems threaten the group's ability to perform its task effectively. The following were three modes of adaptation observed in groups' process in this study:

(a) Leaders emerged where needed. On the posttest, larger groups reporting a need for a leader also tended to report that a leader or leaders had emerged, if none had been selected prior to the task.

(b) Group structure changed to successfully coordinate members' participation. Video tapes of groups answering multiple-choice questions revealed marked differences between the process of smaller and larger groups. Small groups of three members discussed much relevant information, and attempted to reach a consensus decision. Non-participation in smaller groups was usually treated as a "deviant" behavior, and comments were frequently directed at non-participants in an attempt to draw them into the group discussion. Larger groups of 5 or more members utilized a more centralized decision-making structure, with discussion directed toward, and coordinated by, a small subset of group members.

(c) The motivation of less competent members to contribute to the group effort decreased more rapidly than for the more competent members, as group size increased. Subject reports to this effect imply that, as it becomes more difficult for a point of view to be heard in the group discussion contributions are likely to be weighted favorably, as the proportion of competent contributors increases.

All three modes of adaptation noted here are closely related, to the extent that they covary highly and serve the same function, that of process

loss reduction in the group, by avoiding coordination problems.

Such adaptive changes are most marked for groups of "critical size," where increasing process problems are immediately apparent to group members, and group performance deviates from the trend established over smaller group sizes (c.f. Steiner 1972, p. 97; Castore, 1962). This suggests that the relationship between group size and process losses is quite complex and merits further investigation before Steiner's (1972) group productivity model can be entirely effective in the prediction of actual group productivity from an estimate of potential group productivity.

Groups of five do not appear to be as effective as Slater's (1958) subjects reported. For a number of studies the size five seems to be a point where performance is being adversely affected by process problems, but the need to adapt the group's process to the demands imposed by increasing size is not readily apparent (Kelley, et.al., 1965; Hackman & Vidmar, 1970; Jorgensen pilot study).

Groups can be effective facilitators of the individual acquisition of knowledge. A specific application of this information is the administration of examinations to small groups, as a supplementary teaching device. Considering the many possible criteria of success for a small group examination, particularly the acquisition of knowledge and increased individual participation and involvement for large courses, the group size of 3 is recommended. Students should not, however, be permitted to select their preferred group size, since, as previously implied, participant perceptions may not be accurate.

TABLE I

Mean Performance Scores as a Function of

$Time_{1g}$ Group Size

Performance Measure[a]	GROUP SIZE 1	2	3	5	7	All Sizes	
$Time_{1g}$	4.36	4.92	6.59	7.00	7.38	5.90	***
	(11)[b]	(12)	(12)	(8)	(8)	(51)	
$Time_{2i}$	4.63	5.42[c]	5.93[d]	5.80[d]	6.42[d]	5.90	*
	(8)	(19)	(27)	(25)	(42)	(121)	
Non-Experimental Individuals (First Time on Task at Time 2)						4.18	
						(120)	

[e] Underlined means do not differ significantly from one another.

*P < .02
***P < .001

a Scores could range from 0 to 8.
b Number of subjects indicated in parentheses; group totals indicated for $Time_{1g}$.
c Differs from performance of non-experimental individuals. $p < .03$.
d Differs from performance of non-experimental individuals. $p < .001$.

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